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WDMA Optical System Designing with Simulating Tools and Codes

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***Abstract*— The customized and service-orientated all-optical network can implement ultrahigh speed transmission, routing and switching of data in the optical domain, and has the transparency to data formats and protocols which increases network flexibility and functionality such that future network requirements can be met. OCDMA technology is one of the promising technologies to implement all-optical networks, which has the potential to exploit the previously unmined bandwidth of optical fiber and take advantage of the predominance of radio CDMA, such as subscribers' flexible and effective sharing of the spectrum, time and space resources, and resisting jamming and eavesdropping.**

OCDMA has many advantages, such as asynchronous random access, simple management, flexible networking, good compatibility with WDM and TDM, suitable for bursty traffic, supporting multiple services and differentiated QoS, while providing some confidentiality of data transmission. It is a very important technology to implement optical access networks, metropolitan area networks and optical signal multiplexing and switching in backbone networks. The paper aims to explore some of the aforementioned features of OCDMA systems via study of various source coding techniques. Based on the study, different OCDMA systems have been realized with and without 1D prime codes. The OCDMA system using 1 D OCDMA codes has been designed for varying wavelengths. The BER and Q Factor for both systems with varying number of users have been analyzed at varying data rates and fiber length.

***Index Terms*— OCDMA, WDMA, BER, NRZ & Optisystems.**

I. INTRODUCTION

OCDMA is a technology to realize multiplexing transmission and multiple accesses by coding in the optical domain, which supports multiple simultaneous transmissions in the same timeslot and the same frequency [1]. In an OCDMA network shown in Figure 1, the transmission signal overa fiber-optic channel is formed by the superimposing of pseudorandom OCDMA signals encoded from multiple channels. The signal is broadcast to each node (subscriber) in the network and a receiver in each node decodes the signal. If the output of the decoder in this receiver is an autocorrelation, the node can detect the information sent to it from the aforementioned pseudorandom signals. Alternatively, if the output of the decoder is a cross-correlation function (no apparent peak value), then the node cannot receive the information [2]. Therefore, in order to implement OCDMA communication and networking, address codes with sufficient performance are required. This requires that the address codes satisfy two conditions:

- all address codewords can be easily identified from shifted versions, and all address code words can be easily distinguished from every other codeword.

From the viewpoint of coding theory, the address code words need to satisfy the following two criteria:

1- each codeword in a set has a high autocorrelation peak and low autocorrelation side lobes

2- the cross-correlation function between each codeword and any other codeword in the same set of address code words is low.

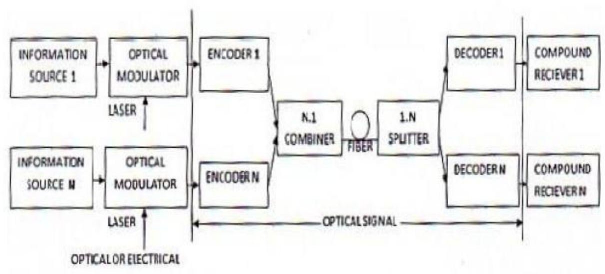

Figure 1: Block Diagram of OCDMA Network

II. DESIGN PROCESS

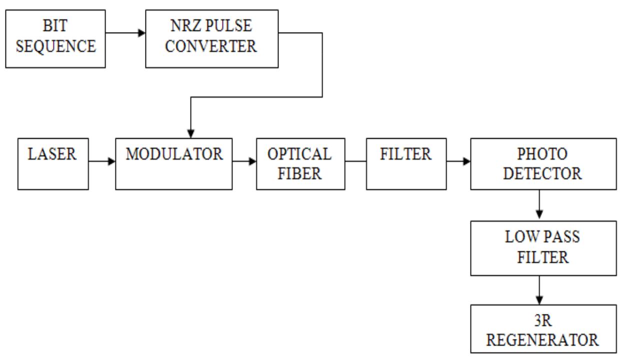

Figure 2: Block diagram for Design Process

The block diagram as shown in figure 2, consists of bit sequences; it can be user defined or pseudo random or both. NRZ converter i.e. non return to zero converters is used to convert the binary sequence to NRZ format. It is then modulated with the source i.e. a laser it produces a sharp beam and in OCDMA it is the prime requirement to produce a sharp beam as users are separated by a narrow channel spacing and if laser does not produce a sharp beam then there will be interference and overlapping of the inputs at the transmitter and data send will not be received at the destination properly. At modulator NRZ data is modulated with the laser source. If both sequences are used at the bit sequence then a multiplier is

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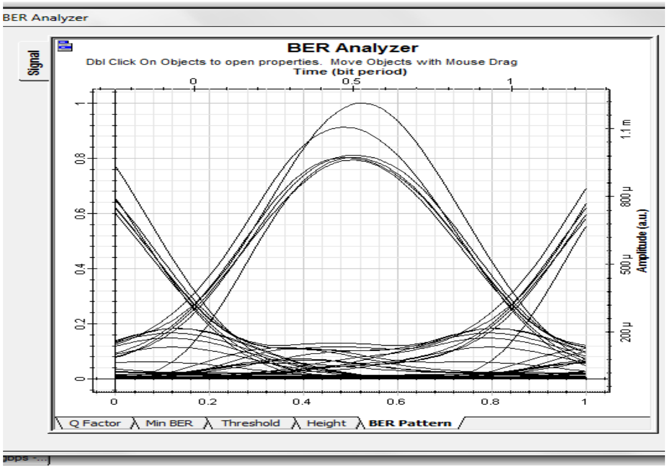
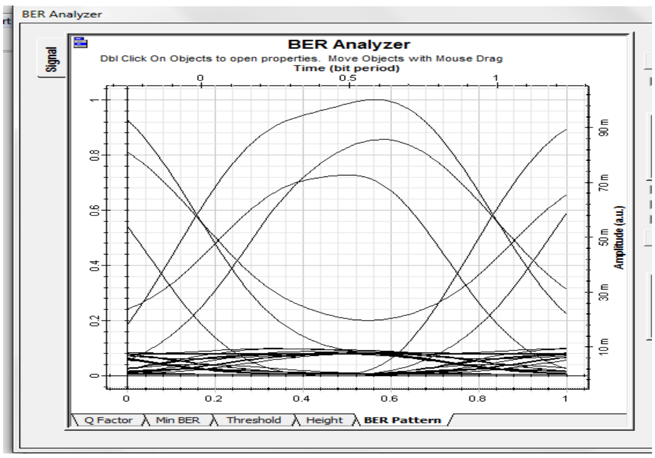
used to multiply their NRZ outputs and then it is given to the modulator. The data encoded from all users are multiplexed and passed over the optical fiber of defined length followed by a FBG i.e. fiber Bragg grating to filter the incoming signal, signal is then converted to electrical form with the help of photo detector, electrical signal is then passed to low pass filter to get the signal at desired wavelength and to filter out the unwanted wavelengths. Finally, it is given as input to the 3R regenerator for re amplification, reshaping and retiming of the signal.

III. EYE PATTERN ANALYSIS

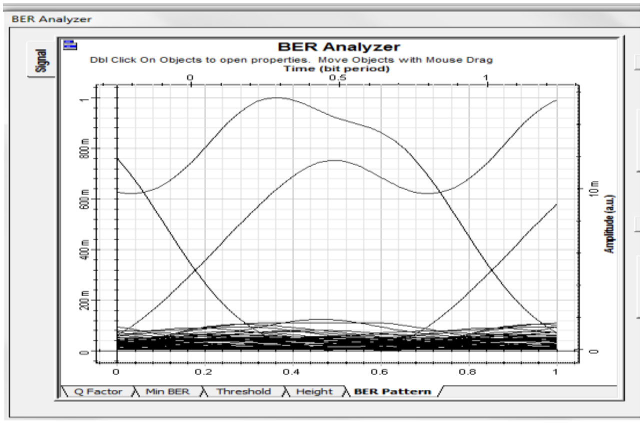
In communication system, an eye pattern, also known as an eye diagram, is an oscilloscope display in which a digital data signal from a receiver is repetitively sampled and applied to the vertical input, while the data rate is used to trigger the horizontal sweep. It is so called because, for several types of coding, the pattern looks like a series of eyes between a pair of rails. Several system performance measures can be derived by analyzing the display. If the signals are too long, too short, poorly synchronized with the system clock, too high, too low, too noisy, or too slow to change, or have too much undershoot or overshoot, this can be observed from the eye diagram. An open eye pattern corresponds to minimal signal distortion. Distortion of the signal waveform due to inter symbol interference and noise appears as closure of the eye pattern.



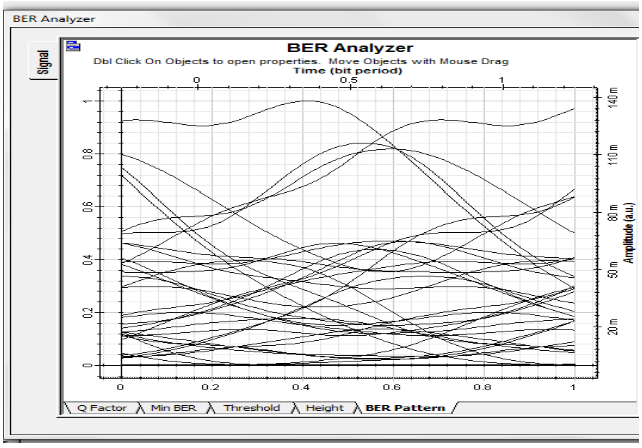
(a) Number of Users = 1



(b) Number of Users = 5



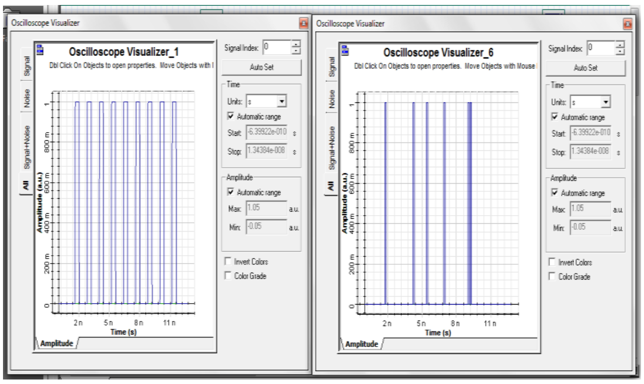
(c) Number of Users = 7



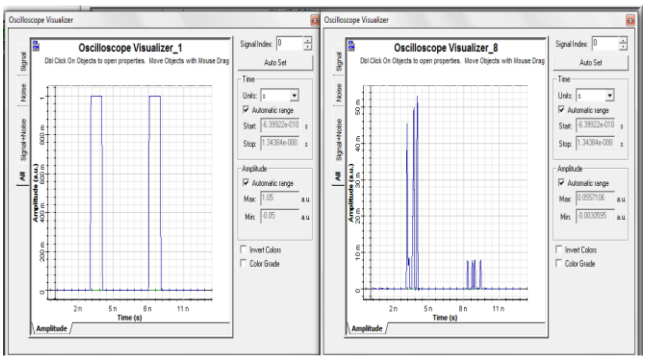
(d) Number of Users=15

Fig. 3shows eye patterns for multiple users at 2.5 Gbps.

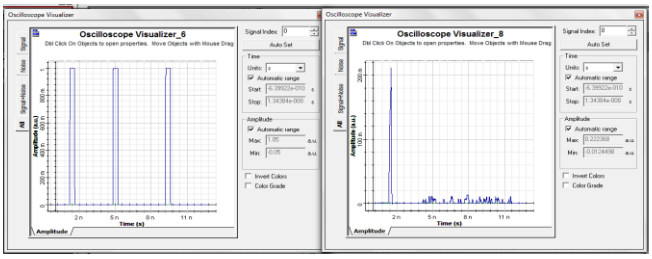
OSCILLOSCOPE VIEW



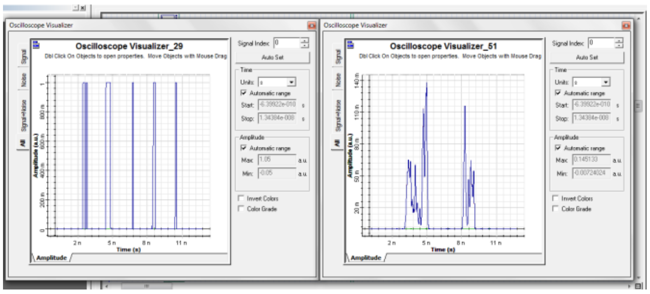
(a) Number of Users = 1



(b) Number of Users = 5



(c) Number of Users = 7



(d) Number of Users = 15

Figure 4

IV. RESULTS AND CONCLUSION

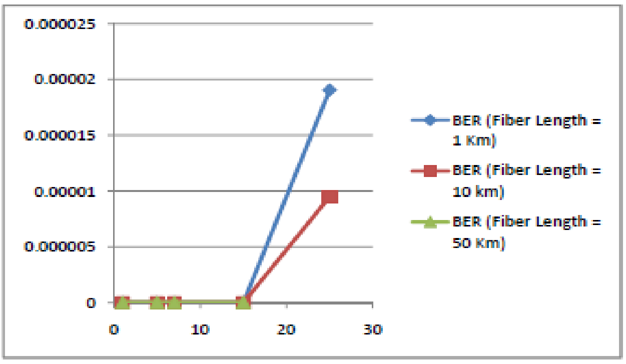


Fig 5 Number of users vs BER at 2.5 Gbps

The results are analyzed for two different optical systems, one employing WDMA technique and other employing OCDMA technique with prime codes as user data. Result analysis includes three different parameters viz. bit error rate (BER), Q- Factor and eye pattern with respect to the number of users. The number of bit errors is the number of received bits of a received stream over a communication channel that has been altered due to noise, interference, distortion or bit synchronization errors. The BER is the number of error bits divided by the total number of transferred bits during a particular time interval. Ideally, its value should be 10-9 . OCDMA systems are used for large amount of user data signals over a single wavelength link.

Theoretically, for an OCDMA system low BER and High Q factor are preferable. However, it is not feasible practically. Simulation results of WDMA system show that with an increase in number of users, BER increases while Q- factor reduces, which is undesirable. This may be attributed to the effect of increasing data rate and length of the fiber. If users are increased with data rate and fiber length beyond a certain limit in the network, interference is increased which leads to distorted eye patterns resulting in poor signal quality and increased noise level. On the other hand, improved results are obtained when OCDMA system is deployed. Significant reduction in BER and improved Q- factor have been observed with increasing number of users up to certain permissible value of data rate and fiber length. Results can be further improved by using repeaters along the fiber. From the Figure 5, it is evident that OCDMA system uses only one receiver and regenerator circuit at the destination. This makes the system cost- effective. Besides, user data is made secure through the use of optical codes.

V. FUTURE SCOPE

The performance of OCDMA systems at higher data rates and increased fiber lengths can be further improved by using repeaters along the length of the fiber. Signal security can be enhanced by using more effective OCDMA codes such as 3-D codes using space as third dimension in the network.

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